

Reviewer Comments on Manuscript Submitted to *Geophysical Research Letters*:

Title: Characterizing Storm-Induced Dune Erosion: Implications to Coastal Modeling

Authors: J. R. Overbeck^{1,2}, J. W. Long¹, and H. F. Stockdon¹

1. U.S. Geological Survey, St. Petersburg Coastal and Marine Science Center 600 4th St South, St. Petersburg, Florida, USA 33701, USA

2. Currently at, State of Alaska, Department of Natural Resources Division of Geological & Geophysical Surveys, 3354 College Rd., Fairbanks, Alaska, USA 99709

This manuscript presents an analysis of coastal dune morphologic change at numerous sites along the NE US Atlantic coast during a major storm that significantly elevated coastal water levels. The results of the before-after morphologic observations (from LiDAR data) are interpreted with respect to improving numerical models of coastal change resulting from storm impacts. This work is certainly relevant, not just to coastal and nearshore researchers, but also to planners, municipality managers, property owners, and other stakeholders within coastal communities. Although the science presented in the manuscript is not particularly transformative, it represents a necessary step forward in our understanding of coastal dune behavior, a topic critical to the study of the geomorphology of low-lying sandy coasts. The authors have done well to capitalize on an infrequent, “extreme” event (Hurricane Sandy in 2012) to reveal several not-often-witnessed behavioral phenomena of dunes during wave impact and inundation. The manuscript is organized, well-written, and presents topics in a logical order, making it a fairly easy read.

My professional opinion, after reviewing this manuscript, is that the work may be worthy of publication, provided several key comments are addressed (see below for specifics). My formal recommendation to the editorial staff at GRL is somewhere between “accept pending minor revision” and “accept pending major revision.”

General Comments:

*A note about the format of the article provided to review – it is notably cumbersome to review an article without line numbers. Their absence makes it difficult to identify specific suggestions regarding wording and content.

My only major comments are about the calculation of “normalized dune crest elevation change”. It was unclear from the manuscript, whether the authors used elevation or height (i. e. above the dune toe) to make the calculation of $\Delta Z/Z_c$. I think it’s more appropriate to compute this value as $\Delta Z_c / (Z_c - Z_t)$, and refer to it as “normalized dune height change”. Presumably the elevation is with respect to some datum tied to the water level, rather than a morphologic position on the beach, so this would make comparisons of $\Delta Z_c / Z_c$ to include the confounding factor of “just how high the dune toe is above the mean sea level”, a complication that might

mask some of the true morphologic behavior of the system. I would recommend that this calculation be recomputed for the data set to see if the results are maintained. They may even be more clearly elucidated by the recalculation (i.e. less scatter).

Specific Comments:

Bottom of p. 2: “using observations over a wide geographic area...” - Are the observation areas geomorphically diverse or similar? There’s really no mention of this, yet the results are interpreted as if the sampling was not biased toward a specific geomorphic environment. As an analogy, if I were asking the question “what kinds of fruits are grown in North America?”, but I only sampled from orange groves in Florida, the results might be inappropriately skewed toward the citrus side of things. Some wording about the geomorphic settings where observations were selected and the implications of the results could help to clear this up.

p. 4, 2nd paragraph: “extract dune morphology at over 800 locations...” – Related to my previous comment, if the environments are different, won’t the transect spacing “weight” the results unevenly?

p. 6, first sentence: “Lidar data was interpolated...”, should probably be changed to “Lidar data were interpolated...”.

p. 6, bottom paragraph: The descriptions of the methods used for calculating morphometrics of features here is thorough, yet terse. My compliments, as this is not often the case.

p. 7, bottom paragraph: “Time-series of modeled H_0 , T_0 , and η were interpolated to the 20-m contour...” - Does this assume that there will be standard Airy wave transformation (shoaling and refraction) to the 20-m isobath? Might need to be a bit more specific about what’s included in the COAWST modeling.

p. 8, top: “steepened (Figure 2a-c) and flattened (Figure 2d)...” – This is a personal pet peeve = “flattened” doesn’t necessarily mean “less steep”, but rather “more planar”.

p. 8, Fig. 2: Several questions about this figure: (1) Which way is seaward/landward? (2) If seaward is to the right, why is an upward trajectory considered to be negative (2a)? (3) Where are these examples taken from?

p. 9, top: “(β_D approaching -0.999 indicates a vertical face).” - I don’t see how -0.999 radians equals a vertical face - it seems to me that a vertical face should occur at 1.57 ($\pi/2$) radians (90 degrees).

p. 9 top: “all of the dunes that overwashed were flattened,” - There’s that misuse of “flattened” again.

p. 9, Fig. 3 caption: “(a). Normalized changes to the dune crest elevation ” - Is Z_c measured as vertical distance above dune toe elevation? According to the definitions provided above, I don’t think so and I’d have to take issue with this. Comparing the same delta Z_c for dunes with

different Z_t would yield misleading results.

p. 9, bottom: “For comparison, 70% of the observed dune toe trajectories had a sign consistent with an alternate formulation based on the slope between the pre-storm dune toe and dune heel, θ_H (Figure 4).” - This sentence should be rewritten for clarity. I don’t understand what is meant by “a sign consistent with an alternate formulation...”

p. 10, first line of text: “Normalized dune crest elevation change, $\Delta Z_C/Z_C$, increased with increasing F ...” - I don’t consider this to be an accurate assessment of figure 3a. The spread in normalized dune crest elev. increases as F becomes less negative.

p. 10, 3rd line down of text: “where overwash occurred despite negative F computed using the predicted TWL;” - Explain how this happens.

p. 10, 5th line down of text: “overwash was observed” - How did you observe overwash? Were there field observations during the storm? Because modeled TWL doesn’t seem to indicate that overwash occurred, right?

p. 10, last sentence of 1st paragraph: “where only dune erosion was observed...” - Is this meant to say “where only dune collision was observed”? Basically an assessment of the information presented in Fig. 3b? Please clarify.

p. 10, 2nd paragraph, reference to figure: “...observed (Figure 3b)” – Should this be a reference to Figure 3c?

p. 10, 3 lines up from bottom of page: “where dune erosion was expected” – again, shouldn’t this read “dune collision”?

p. 12, end of 1st paragraph: “A higher percentage of the observed θ_T were of the same sign as θ_H ” – This is an interesting finding. Could the authors comment on the implications of this observation?

p. 13, last words on the page: “Results indicate that erosion of the dune crest” - Perhaps the authors might consider substituting “dune crest lowering” for “erosion of the dune crest”?

p. 14, Figure 5. This coloring scheme for data dots on 5a, b, and c needs to be better explained.

p. 15, last sentence of 2nd paragraph: “A positive (downward) dune toe trajectory...” - Not sure this positive/downward convention is consistent with other gradient calculations in geomorphology.

p. 15, “The vulnerability of the coastline increased to future storms because of reductions to dune volumes ...” – please rearrange this word order, or rewrite the sentence as it is a bit confusing.